# Validation of the SAFRAN meteorological analysis system in the Northeast of Spain

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## Introduction

This work belongs to our effort to build a distributed hydrological model for the North-East of Spain, including the Ebro river basin. It is based on the SURFEX/ISBA land-surface model (`http://www.cnrm.meteo.fr/surfex/`). High quality meteorological data is needed to force SURFEX. Such a dataset can be created using a meterological analysis system. In this study we validated the SAFRAN analysis system and compared it to SPAN.

## Meteorological Analysis

Data from a meteorological model and meteorological stations is used to obtain a best estimate of the real meteorological fields.

## SAFRAN

SAFRAN (Quintana-Seguí et al. 2008 and Vidal et al. 2010) is based on optimal interpolation over climatically homogeneous zones (areas where spatial gradients of meteorological variables are not very relevant) and is able to reliably take vertical variations into account. SAFRAN is currently operational at Météo-France, as part of the SIM hydrometeorological suite (Habets et al. 2008).

## SPAN

SPAN is the surface analysis of the HIRLAM Analysis and Forecasting System, running operationally at AEMET and the rest of HIRLAM countries. It was developed by AEMET as part of its contribution to the scientific plans of the NWP European Consortium HIRLAM. It is also based on optimal interpolation.

## Methodology and data

- **Area of study:** NE of Spain, including the Ebro river basin.
- **Period:** Sept 2009 - Aug 2010: 1 hydrological year.
- **Observations:** Data from the climatological and synoptic databases of the Spanish meteorological service (AEMET): 3509 stations of precipitation, 128 stations for the rest of variables.
- **Meteorological Model:** Both SAFRAN and SPAN analyses were performed using the current operational meteorological model at AEMET (HIRLAM-HNR, 5 km of resolution).
- **Grid:** Both analysis systems use the same grid with a resolution of 5 km.
- **Variables:** SAFRAN analyses Temperature, Precipitation, Wind Speed, Relative Humidity and cloudiness. Not all variables will be shown in this poster.

## Comparison to the observations

Our final product, which will be used to force the land-surface model, is gridded. Each grid point has a defined altitude, which usually is different to the altitude of the observations. But SAFRAN calculates the value of each variable at different altitudes (every 300 m), therefore, it is possible to vertically interpolate the values of SAFRAN at the desired altitude. Therefore, we compare SAFRAN with the observations at both the altitude of the stations and the grid points, to estimate the error due to the use of a grid.

- **SF-M:** SAFRAN and the observations are compared at the same altitude.
- **SFR-M:** SAFRAN is set at the altitude of the grid at the point of the observation, therefore, it is not at the same altitude as the observation.
- **SP:** SPAN at the altitude of the grid.

## Mean Fields

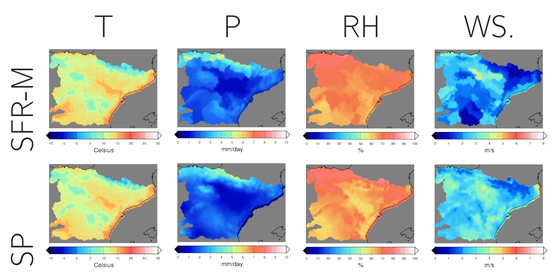


Figure: Mean fields yearly (Sept 2009- Aug 2010) of the main variables as analysed by SAFRAN (SFR-M) and SPAN (SP).

## Daily cycle of errors.

| | *< Bias >* | | | | *< RMSE >* | | | |
|---|---|---|---|---|---|---|---|---|
| Hora | SF-M | SFR-M | SP | HIR | SF-M | SFR-M | SP | HIR |
| | Temperature (°C) | | | | | | | |
| 00 | 0.0 | -0.2 | -0.1 | -0.9 | 0.9 | 1.2 | 1.6 | 2.1 |
| 06 | 0.0 | -0.2 | -0.2 | -0.6 | 1.2 | 1.4 | 1.6 | 2.2 |
| 12 | -0.1 | -0.4 | -1.8 | -1.1 | 1.0 | 1.6 | 2.7 | 2.4 |
| 18 | -0.0 | -0.4 | -0.6 | -0.6 | 0.8 | 1.3 | 1.6 | 2.0 |
| Media | -0.0 | -0.3 | -0.6 | -0.8 | 1.0 | 1.4 | 1.9 | 2.2 |
| | Wind Speed (m/s) | | | | | | | |
| 00 | -0.3 | -0.3 | -0.1 | 0.5 | 1.0 | 1.1 | 1.4 | 1.9 |
| 06 | -0.3 | -0.3 | -0.1 | 0.6 | 1.0 | 1.1 | 1.4 | 2.0 |
| 12 | -0.4 | -0.4 | -0.3 | 0.3 | 1.2 | 1.2 | 1.6 | 2.0 |
| 18 | -0.3 | -0.4 | -0.3 | 0.4 | 1.1 | 1.2 | 1.5 | 1.9 |
| Media | -0.3 | -0.4 | -0.2 | 0.5 | 1.1 | 1.1 | 1.5 | 2.0 |
| | Relative Humidity (p.p.) | | | | | | | |
| 00 | -0 | -1 | -3 | 0 | 6 | 7 | 10 | 13 |
| 06 | -0 | -1 | -3 | -1 | 7 | 8 | 10 | 13 |
| 12 | 0 | 0 | 2 | -0 | 7 | 8 | 9 | 12 |
| 18 | 2 | 1 | -1 | -1 | 9 | 10 | 10 | 13 |
| Media | 0 | 0 | -1 | -1 | 7 | 8 | 10 | 13 |
| | Precipitation (mm/día) | | | | | | | |
| Día | -1.3 | -1.1 | -1.8 | -4.0 | 6.4 | 6.4 | 7.4 | 11.7 |

Table: Mean bias and RMSE of SAFRAN, SPAN and HIRLAM on the stations used to perform the analysis.

## Monthly cycle of bias

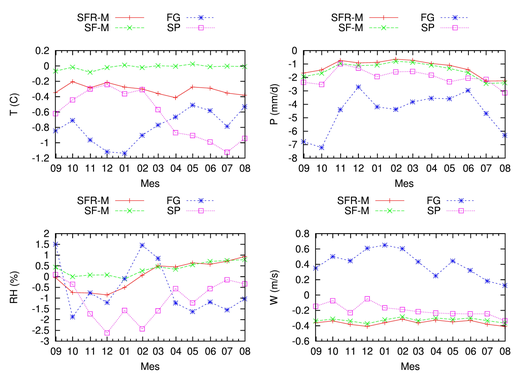


Figure: Monthly cycle of the mean bias of SAFRAN, SPAN and HIRLAM on the stations used to perform the analysis.

## Monthly cycle of RMSE

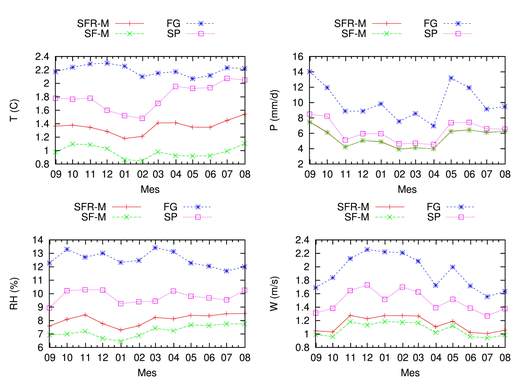


Figure: Monthly cycle of the mean RMSE of SAFRAN, SPAN and HIRLAM on the stations used to perform the analysis.

## Precipitation

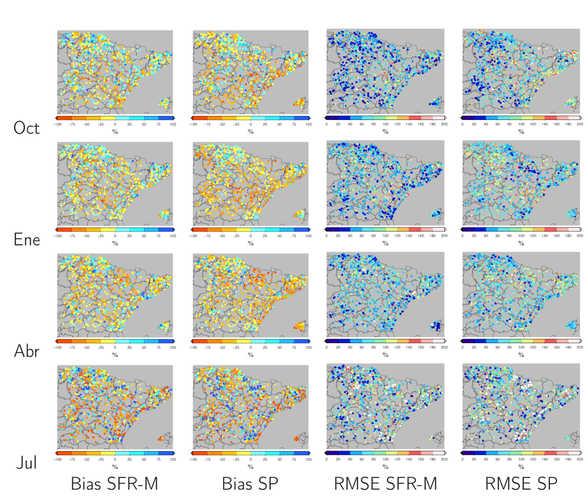


Figure: Bias and RMSE of precipitation of SAFRAN and SPAN on the stations used to perform the analysis.

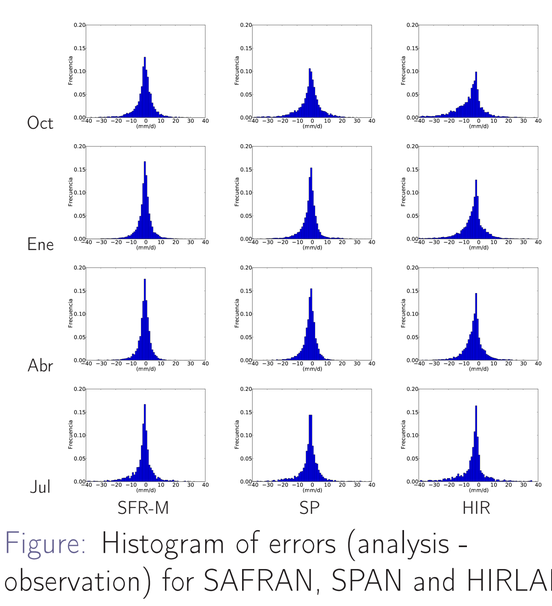


Figure: Histogram of errors (analysis - observation) for SAFRAN, SPAN and HIRLAM.

## Temperature

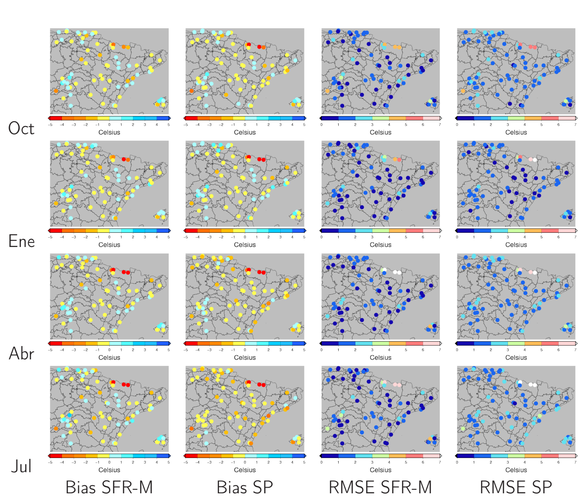


Figure: Bias and RMSE of temperature of SAFRAN and SPAN on the stations used to perform the analysis.

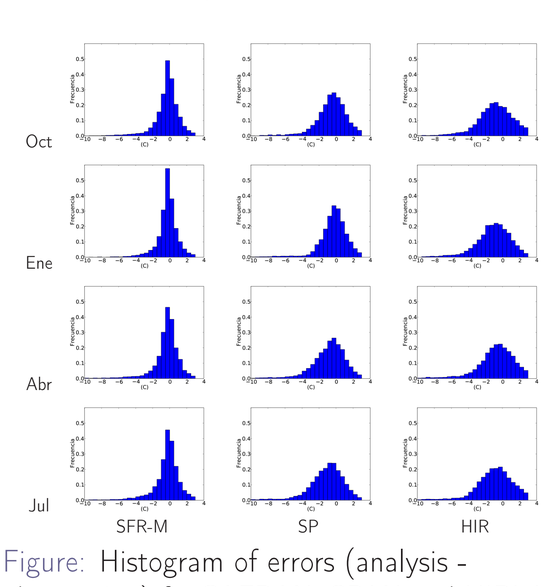


Figure: Histogram of errors (analysis - observation) for SAFRAN, SPAN and HIRLAM.

## Conclusions and Future Work

SAFRAN and SPAN are able to correctly reproduce the daily and the annual cycle of the variables, being SAFRAN's performance slightly better for all measures and variables, with one exception: it has a systematic bias of wind speed. Both SAFRAN and SPAN produce similar spatial patterns of the errors, but there are some differences in very specific areas and seasons, mainly on the relief, where both systems have more problems.

**The performance of both systems is adequate to be used as input data for a land-surface model.**

## Future Work

The implementation of SAFRAN on this area will allow the study of the continental hydrological cycle on the Ebro river basin, by means of a land-surface model. Also, SAFRAN will become a very useful database for statistical downscaling of climate scenarios. These studies will be performed under the umbrella of the HyMeX program (`http://www.hymex.org`), which focuses on the water cycle in the Mediterranean basin, and the SMOSCat project (`http://www.isardsat.cat/en/smoscat.html`), which plans to downscale SMOS soil-moisture data to a resolution of 1 km. Within SMOSCat, the land-surface model will help in validating the new soil moisture dataset.

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